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The Comparative Profitability and Productivity of a Sample of Irrigated and Non-Irrigated Farms in the Ashburton-Lyndhurst Area of Mid-Canterbury, New Zealand

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The Comparative Profitability and Productivity of a Sample of Irrigated and Non-Irrigated Farms in the Ashburton-Lyndhurst Area of Mid-Canterbury, New Zealand

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The field work was carried out by Messrs P. Brown, K. Elliot, D. Haslam, P. Nuthall, N. Taylor and H. Weir. Messrs Haslam, Nuthall and Taylor have been largely responsible for the massive amount of arithmetic involved in analysing the financial and physical data, and for the tedious job of checking and rechecking the results.

Clarification of views on the method of approach, and on the presentation of this report resulted from discussions with Associate-Professor A. H. Flay and Mr H. E. Garrett.

In due course a further publication is proposed, which will include a series of articles on general economic, management, and financial subjects relating to the survey results.

CONTENTS

SUMMARY

1. Physical and financial data for a sample of irrigated and non-irrigated farms have been collected and analysed.

2. The data covered the three production years: 1959/60, 1960/61 and 1961/62.

3. The number of farms in the survey were:

   A. Irrigated farms on light land 65

   B. Non-irrigated farms on light land 43

   C. Irrigated and non-irrigated farms on medium land 22

4. The measure of economic success used in the financial appraisal was "Owner's Surplus". This was a residual amount after meeting all cash outlays, allowing for depreciation of the farm assets, and for interest at 6 per cent. on the total farm capital, following appropriate adjustments to the farm accounts.

5. Irrigated and non-irrigated farms were compared on this basis, following classification into comparable size groups. Size was measured both in terms of acres of land and total farm capital.

6. The results consistently show that the returns being achieved on irrigated farms do not exceed those being achieved on non-irrigated farms. There is some indication that the reverse may apply.

7. It appears that for the class of land and climate covered by the survey, for the type of farming generally practised, and under existing technological conditions, irrigation does not systematically confer economic gains upon the farmer.

8. On the basis of this research there appear to be no grounds for increasing water charges on irrigated farms, if the criterion adopted in fixing such charges is to be any difference in profitability as between irrigated and non-irrigated farms.

REPORT ON THE COMPARATIVE PROFITABILITY AND PRODUCTIVITY OF A SAMPLE OF IRRIGATED AND NON-IRRIGATED FARMS IN THE ASHBURTON - LYNDHURST AREA OF MID - CANTERBURY, NEW ZEALAND.

I. OBJECTIVE OF THE SURVEY

The survey was requested by the Irrigation Development Association of the Ashburton-Lyndhurst Irrigation Scheme, and was mainly financed by the Association, from levies on its members. The objective was to obtain information on the comparative profitability of irrigated farms and comparable non-irrigated farms. This information was required as a basis for negotiation of new contract rates for irrigation water, the existing contracts being due to terminate at the end of the 1962-63 irrigating season.

The terms of reference within which this report is framed, do not include an appraisal of the general economics of irrigation on the light plains of Canterbury. This is a much wider issue. However, in appendix five, an opportunity is taken to present some facts and make a brief comment on the impact of irrigation on the general level of economic activity in the area.

II. SAMPLING OF FARMS

The approach was to sample all irrigated farms within the Ashburton-Lyndhurst Scheme which conformed to certain requirements, and to compare this with a sample of comparable farms outside the irrigable area.

Irrigated Farms

Firstly, the principal soil boundaries were superimposed on farm-holdings maps of the area. Within the area served by the Scheme two soil categories were of interest. These have been designated "Light land", comprising almost entirely Lismore stony silt loam and a small amount of Eyre stony silt loam, and "Medium land", comprising a group of medium soils, characterised by the Mayfield silt loam. The Light-land category was much greater in area. The approximate boundaries of these soil types are plotted by dotted lines on the map on page 13.

The initial selection of farms proceeded as follows:

(1) observing the valuation roll number of holdings which appeared to fall within the specified soil boundaries,

(2) cross-checking the farm area and survey description with valuation slips, and

(3) recording all farms which totally conformed with the soil classification.

Any farms less than 200 acres were not considered as they were likely to be part-time holdings.

Farms which, on the basis of this first selection, appeared to conform to soil and size requirements were placed on the initial survey list. There were 88 on light land and 19 on medium land.

Non-Irrigated Farms

The problem was to identify a comparable area of light land outside the boundaries of the irrigation scheme, as there were few non-irrigators within the scheme.

It was necessary to include an area of light land lying between the main Ashburton-Rakaia road and the Wakanui-Seafield-Pendarves Road. The soil-type in this area is classified the same as the light land of the irrigated sector, but it would be recognised by agriculturalists as being slightly inferior. Also, the rainfall in this region tends to be lower than in the irrigated area. Table 1 contains rainfall figures for three strategic points, covering the irrigation seasons relevant to the survey.

TABLE 1

RAINFALL

Irrigation Season	Seafield (inches)	Winchmore (inches)	Lyndhurst (inches)
1958/59	26.91	31.28	32.74
1959/60	23.91	23.35	27.48
1960/61	34.55	32.34	34.84
1961/62	30.8	30.84	32.67
4-year Mean	29.04	29.45	31.93
Mean Annual	26.1	28.4	31.4

Rainfall increases more sharply between Lyndhurst and the foothills, but the light land sample does not extend beyond Lyndhurst significantly. On balance it was judged that the small variations in soil and climate tended to favour the irrigation sample, but that this would not be sufficient to invalidate the comparison. Selection of non-irrigated farms then proceeded on a simliar basis to that of the irrigated farms, the initial list consisting of 72 light land farms, and 11 on medium land.

The first contact with the farmers was made by letter and this was followed by visits by field workers. During the course of the field work, and subsequent data tabulation, the initial selection, as expected, was substantially reduced. The reasons for this further elimination of farms can be classified as follows:

(a) Farmers did not wish to cooperate.

(b) Farmers had not been on the property for the required number of seasons.

(c) Field workers found the initial requirements as to homogeneity of soils were not met.

(d) There were complications in management, such as heavy stock-dealing.

(e) Properties were being farmed in conjunction with land elsewhere.

(f) Financial data for the year 1961/62 could not be made available by accountants in time for the preparation of this report.

Thus, apart from (a), under which there were only ten farms, the above factors were entirely random. No purposive elimination or selection of farms occurred. Every farm in the whole population originally defined, which satisfied the requirements as to soil type and size, and was not eliminated for any of the above reasons, was included in the final survey. The numbers in each group, with the size distribution in acres, are set out in Table 2.

TABLE 2

SIZE DISTRIBUTION OF SURVEY FARMS

A. LIGHT LAND FARMS

	No. of farms		
	1. Irrigated	2. Non-Irrigated	3. Total
200 — 399 acres	28	3	31
400 — 599 „	21	15	36
600 — 799 „	9	12	21
800 — 999 „	3	5	8
1000 — 1199 „	3	6	9
1200 + „	1	2	3
TOTAL	65	43	108

B. MEDIUM LAND FARMS

	No. of farms		
	1. Irrigated	2. Non-Irrigated	3. Total
200 — 399 acres	13	2	15
400 — 599 „	3	3	6
600 — 799 „	1	—	1
TOTAL	17	5	22

III. FIELD WORK

The field work was carried out during November - December, 1962. Each farm was visited and inspected by the field worker with the farmer. The purpose of the inspection was to check on soil types, and to give the field worker a background for the subsequent discussion and tabulation of management details, physical and financial data. Some of this material was not relevant to the immediate objectives of the survey, but the opportunity was taken to secure any information which would be useful in further farm management research.

A schedule of questions was completed, and financial acounts for the seasons 1959/60, 1960/61 and 1961/62 were obtained.

IV. THE SURVEY PERIOD

In choosing to survey the three financial years 1959/60, 1960/61 and 1961/62 the following factors were taken into account.

(a) The need to have a sufficient number of years to smooth out seasonal variations, but not so many years as to be involved in substantial technological change.

The figures given in Table 1 show that rainfall was low in 1959/60, moderately high in 1960/61 and moderate in 1961/62. But a more accurate indication of the effectiveness of this rainfall is given by figures of soil moisture in Table 3.

TABLE 3

AVERAGE MONTHLY SOIL MOISTURE
AS A % EXPRESSED ON THE DRY WEIGHT OF SOIL
0 - 4ins. NON-IRRIGATED AREA WINCHMORE*

	1959/60	1960/61	1961/62
October	17.9	22.0	17.4
November	10.6	17.6	8.0
December	15.7	22.0	12.0
January	11.0	16.0	11.0
February	9.3	23.4	13.2
March	15.5	27.0	18.4
	13.20	21.33	13.33

11-year average for Jan, Feb, March, Oct, Nov, and Dec, 1952-62 = 15.83.

* Provided by the Winchmore Irrigation Research Station, Department of Agriculture.

In the 1961/62 season conditions were extremely dry in the crucial early months. 1960/61 was a wet season and in 1959/60 while the average soil moisture level over the six months was low, the earlier months were not as severely dry as in 1961/62. The three survey years represent a reasonably good cross-section of seasons.

(b) If there were substantial differences in the pattern of production between irrigated and non-irrigated farms, the results would be influenced by changes in the ratio of product prices. But the pattern is not greatly different (see appendix five). Rather more cash cropping is done on non-irrigated farms and more cattle are run on irrigated farms (6 per 100 ac. on a group of intensively irrigated farms and 2 per 100 ac. on a comparable group of non-irrigated farms). Fat lamb and wool production is predominant on both types of farms, so that variation in price ratios between sheep products and cash crops is not of great significance to the study. However, some relevant prices are given in Table 4.

TABLE 4

PRODUCT PRICES DURING SURVEY PERIOD

LAMB SCHEDULE 29/36 lbs.

	Price per lb.		
	Opening	**January**	**May**
1959/60	13d.	17d.	19½d.
1960/61	20d.	17d.	17½d.
1961/62	16¼d.	12¼d.	16d.

WOOL PRICES (Christchurch February Sales)

	50/56 B	**46/48** B
1960	49¾d.	47¾d.
1961	49d.	46d.
1962	48¾d.	43½d.

NOTE: The price of wheat was stable during this period.

V. STANDARDIZATION OF FARM FINANCIAL DATA

A. Farm Capital

A_1 Land and Improvements

The capital value from the current government valuation was used. The latest Ashburton County revaluation was issued in 1961, the mid-year of the survey period.

A_2 Plant and Machinery

The average book value of the plant and machinery from the farm accounts. (Details are given in appendix 1).

A_3 **Livestock**

The value of the annual average number of stock on the property during the survey period. (Details are given in appendix 2).

A_4 **Working Capital**

An allowance for liquid cash necessary to run the farm. This was estimated as one-half the average annual sum of all cash expenses, excluding outlays on stock, rent, interest and development, and including an allowance for owner-occupier's drawings. The latter was calculated as £675 + 1% of the total capital involved in A_1, A_2 and A_3.

Total Farm Capital is the sum of the four items under A_1 A_2, A_3 and A_4.

B. Farm Income

B_1 **Average Gross Profit on Sheep**

This figure was obtained from a three-year sheep trading account, with 1959 opening unit values and 1962 closing unit values the same as for A_3. Purchases and sales were summed from the sheep trading accounts of each of the three years.

B_2 **Average Gross Profit on Cattle**

As for B_1.

B_3 **Average Gross Profit on Wool**

The average of the three years' gross profit on wool. In the event of the farmer having wool on hand at either the 1959 opening or the 1962 closing balance a trading account similar to that for the livestock accounts was constructed.

B_4 **Average Gross Profit on Grain, Seeds and Produce**

As for B_3 including sales of hay.

B_5 **Other Farm Income**

Includes the average of the following items:

(a) Grazing sold.
(b) Contract work done.
(c) Dairy produce sold.
(d) Produce used in the house.

Total Farm Income is the sum of B_1 to B_5.

C. Farm Expenses

The expenses figures are all averages of the three survey years. Variations in accounting procedure meant that considerable aggregation of expenditure items was necessary.

C_1 **Wages**

All wages paid to employees, including shearers, but not including working managers.

C_2 **Vehicle and Machinery Expenses**

Includes fuel and oil, farm share of car expenses, minus petrol rebates.

C_3 **Contract and Cartage**

(1) All contract work done for the farmer, including fencing, liming (spreading only), topdressing (spreading only), cultivation, gorse cutting, race cleaning, harvesting, hay baling and cartage, dipping.

(2) All freight and cartage.

C_4 **Repairs and Maintenance**

All repairs to farm buildings, fences, and the farm share of dwelling expenses, all maintenance of plant and machinery including the farm share of car maintenance.

C_5 **Farm Purchases**

Seeds, manures, stores and rations, stock feeds, dips and drenches, sacks and twine, and other general farm expenses.

C_6 **Sundry Overheads**

Includes insurance, rates, land tax, power, veterinary expenses, accountancy and legal fees, postal and telephone expenses.

C_7 **Irrigation Charges**

The actual charges were obtained from the Ministry of Works. Where there was a discrepancy between this figure and the book figure, or no book figure at all, the Ministry of Works' figure was taken, and corresponding adjustments were made to general expenses.

C_8 **Depreciation**

Depreciation of plant and machinery as explained in appendix 1, plus depreciation on farm buildings, plus farm share of depreciation on farm dwelling.

C_9 **Rent**

As per the accounts.

C_{10} **Interest**

As per the accounts, including mortgage interest, and interest on current account.

C_{11} **Development**

This item includes new border dyking and other developmental expenses.

VI. MEASUREMENT OF THE FINANCIAL RESULTS

The financial result achieved by each of the survey farms was expressed as the average "Owner's Surplus". The calculation for this was:

[Total Farm Income (B_1 to B_5 inclusive)] — [Farm Expenses (C_1 to C_8 inclusive) + Interest on Total Farm Capital @ 6%].

Thus, any rent or interest paid was excluded in order to bring all farms to an initial comparable freehold — free of debt basis. Development expenditure under C_{11} was omitted. It has already been noted under C_1 that where a salary to an employed working manager was being paid this was excluded from the calculation of farm expenses, again in order to bring all farms to a comparable owner-occupier basis. Appropriate adjustments were also made in cases where there were departures from the owner-occupier system, such as partnerships and private companies.

Thus "Owner's Surplus" is the residual amount to reward the owner-occupier for his labour and management, after allowing for all comparable farm expenditure, including depreciation, and for interest at the current market rate on the total capital which is involved in the farm business. This measure has been used because it is believed that it is the most logical measure of differences in profitability between farms when there are substantial differences in the capitalization of these farms.

VII. ANAYLSIS OF FINANCIAL RESULTS

The aim of the analysis was to compare the profitability of irrigated farms with that of non-irrigated farms. For the medium-land farms, the sample was too small to proceed with any very detailed analysis, but the individual farm results are presented at the end of this section.

A. The Light Land Farms

The farms were grouped in cells, based on a two-way classification, namely size of farm in acres, and intensity of irrigation. The size groups were determined by consideration of significant size categories and of the number of farms in the sample. Intensity of irrigation was determined by calculating the average annual amount of water used by farmers over the survey period, in relation to the total area of their farms. Four categories were classified.

	Average annual acre/feet of water used per acre of farm *
a. Non-irrigators	—
b. Light irrigators	less than 0.4
c. Medium irrigators	0.4 — 0.79
d. Heavy irrigators	more than 0.79.

The financial results, and other important variables for all the light land farms are given in Table 5 and 6. Table 5 contains all farms less than 700 acres, and Table 6 farms greater than 700 acres. A number of the cells contain very small numbers of farms, and therefore can not be regarded as yielding significant averages. For example, the cell IIId (heavy irrigators on 500-699 acre farms) contains only one farm. It is impossible to avoid this extent of subdivision of the sample when attention has to be given to what are considered significant cells.

* Figures for water used provided by the Ministry of Works.

The first point of interest in the examination of these tables is the degree of change in the proportion with which land and capital are combined as the intensity of irrigation increases. Irrigated farms are more capital intensive, because irrigation involves higher investment in farm improvements and stock per unit of land.

The measure of financial success used in this analysis, "Owner's Surplus" should be considered in relation to total farm capital, rather than to area in acres. For if all differences in managerial skill were eliminated, it would be reasonable to expect average owner's surplus to increase as we moved from farms with lower farm capital to farms with higher farm capital.

It should be recalled that in arriving at the residual "Owner's Surplus", interest on the total farm capital has been deducted. But this in no way influences the above argument, for the interest rate used is only the current market rate. The economic basis for this argument is that when additional capital is invested in a business, it is in the expectation that it will yield an additional return at least equal to the market rate of interest, and at the same time commensurately reward managerial responsibilities, which are increased. There is no reason why the same kind of economic criterion should not be applied to the farm business, and therefore no reason why farmers who invest quite heavily in irrigation should not do so in the expectation that they will earn interest on this investment and at the same time derive a higher managerial reward.

TABLE 5

FINANCIAL RESULTS ON LIGHT LAND FARMS
LESS THAN 700 ACRES

Code: 1. No. of farms.
2. Av. area in acres.
3. Av. acre/feet water per acre.
4. Av. total farm capital (£).
5. Av. Owner's Surplus (£).

	Area (acres)	Code	a. Non-Irrigators	b. Light Irrigators	c. Medium Irrigators	d. Heavy Irrigators
I.	200-299	1.	—	—	4	3
		2.	—	—	255	269
		3.	—	—	0.61	1.13
		4.	—	—	25,041	19,569
		5.	—	—	764	76
II.	300-499	1.	11	11	13	13
		2.	425	413	374	385
		3.	—	0.29	0.64	1.0
		4.	23,118	27,577	28,446	28,029
		5.	1,328	1,226	1,064	772
III.	500-699	1.	14	4	6	1
		2.	585	593	601	631
		3.	—	0.18	0.59	0.94
		4.	29,104	32,036	38,796	51,533
		5.	1,523	966	596	917

TABLE 6

FINANCIAL RESULTS ON LIGHT LAND FARMS
GREATER THAN 700 ACRES

Code: 1. No. of farms.
2. Av. area in acres.
3. Av. acre/feet water per acre.
4. Av. total farm capital (£).
5. Av. Owner's Surplus (£).

	Area (acres)	Code	a. Non-Irrigators	b. Light, Medium and Heavy Irrigators
IV.	700 +	1.	18	10
		2.	972	921
		3.	—	0.34
		4.	45,371	52,207
		5.	2,036	1,942

Tables 5 and 6 reveal that for the average farmer, in the cells where there are sufficient farms to give a meaningful average, this is not the case. On the contrary, there is some indication that the opposite applies, that is, as the intensity of irrigation increases, with corresponding in-

creases in capitalization, owner's surplus tends to decrease. However, this hypothesis is not in all cases sustained by rigorous tests of statistical significance. The lack of large numbers of farms, together with the large amount of variation in "owner's surplus" within the cells, gives mixed results in statistical testing (see appendices 3 and 4).

The most that can be asserted from the results given in Table 5 and 6 is that there is no indication of higher returns to the average farmer resulting from more intensive irrigation, and the associated higher levels of farm investment. There is some indication that the opposite may apply.

There are some by-products of this comparative analysis which are of interest and which are relevant to the question of water charges. For example:

(a) The seven farms in the smallest size category, all in the medium or heavy irrigating class are deriving very low returns after interest on total farm capital is deducted. On the basis of the results they must be regarded as being doubtful economic units at current costs, prices, capitalization, and technology, unless their management is generally inefficient.

(b) The size group 300 - 499 acres contains many units which have resulted from State development and settlement in the irrigation area. This implies that the minimum economic irrigation unit is judged to be in this size category. The results of the analysis do not dispute this, although it will be noted that the average farmer in cell IId is barely making a farm worker's wage after allowing for interest on his capital. But rather surprisingly, the average farmer on non-irrigated farms in this size range, appears to be achieving better results with less capital invested.

(c) For those farms larger than 700 acres it was necessary to group all irrigated farms into one cell, through lack of numbers. The dispersion about the average acreage is therefore quite large. All that can be said about the results given in Table 6 is that there is no indication of increased profitability being associated with the small amount of irrigation which the average farmer is undertaking.

B. The Medium Land Farms

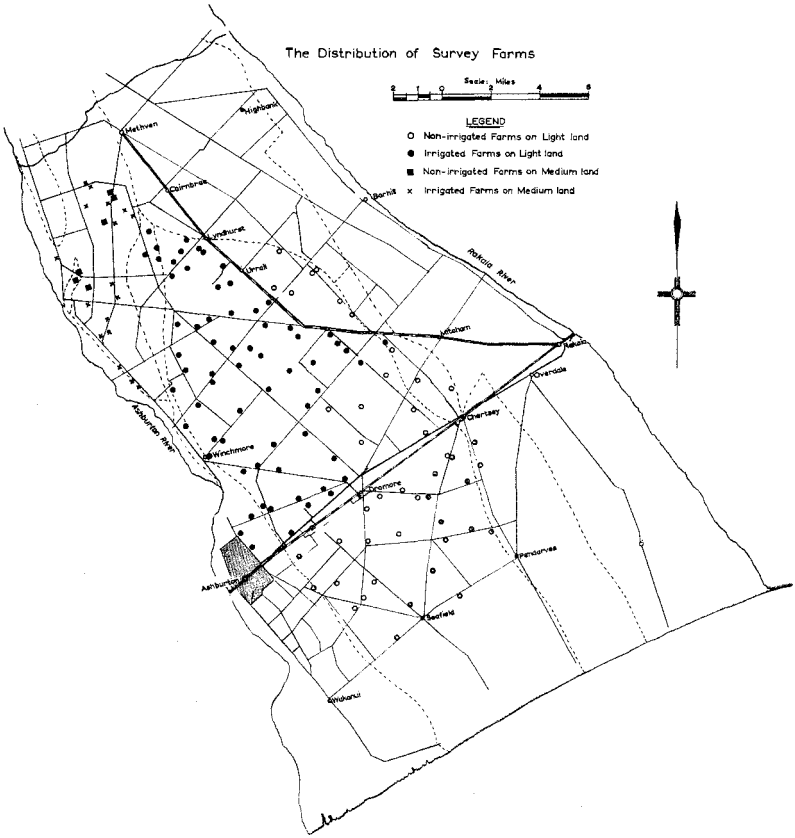
It has been pointed out that the number of farms on the medium soils which it was possible to sample was insufficient to permit systematic analysis of groups. There were 17 irrigators and 5 non-irrigators. In Table 7 these 22 farms have been arranged with the 5 non-irrigators first (code D), and the irrigated farms in order of increasing intensity of irrigation. Statistical analysis would be spurious in this case, but there appears to be no indication of increasing profitability being associated with the level of irrigation.

TABLE 7

MEDIUM LAND FARMS

INTENSITY OF IRRIGATION AND OWNER'S SURPLUS

Farm Code	Acre/Feet Water per Acre	Total Farm Capital (£)	Owner's Surplus (£)
D_4	—	26,686	170
D_9	—	28,091	20
D_1	—	40,018	248
D_5	—	49,267	5,130
D_3	—	52,937	33
C_4	0.12	39,092	1,469
C_{18}	0.16	22,581	910
C_6	0.18	22,786	1,711
C_{11}	0.20	48,764	1,074
C_3	0.25	31,103	1,406
C_1	0.31	30,491	328
C_7	0.31	30,440	2,357
C_{13}	0.36	33,578	1,639
C_{15}	0.42	27,704	1,034
C_8	0.55	55,553	700
C_9	0.56	18,477	46
C_{16}	0.65	26,188	338
C_{17}	0.71	58,262	643
C_5	0.90	36,210	2,415
C_{10}	1.30	29,555	1,724
C_{20}	1.70	25,080	591



VIII. CHANGES IN CAPITAL

If the rate of capital development was significantly different between the irrigated and non-irrigated farms during the period being surveyed, in some circumstances this could invalidate the results of Section VII. This would be the case where heavy outlays of a semi-capital nature, for example topdressing, pasture establishment, fencing replacement, were legitimately appearing as current expenditure in the farm profit and loss account. Where this is the case current farm profit is correspondingly reduced.

It was therefore decided to examine the possibility that the rate of development, as reflected in capital increment, on irrigated farms over the survey period was greater

than on non-irrigated farms. To do this accurately would require a valuation of the property at the beginning and end of the survey period. *

But clearly this was impracticable. As an alternative it was decided to examine the Government Valuations of 1956 and 1961. The assumption was that such an examination would give a guide as to any difference in the rate and level of investment between irrigated and non-irrigated farms immediately prior to and during the first year of the survey period. Moreover, it was thought reasonable to assume that this trend would continue into the survey period.

* It should be noted that changes in the value of stock will already have been taken care of in the accounting procedure outlined in Section V.

TABLE 8

CHANGES IN GOVERNMENT VALUATIONS,1956-61
SURVEY LIGHT LAND FARMS

Size Group (acres)		Irrigated Farms	Non-Irrigated Farms
300 - 599	No. farms	35	11
	% increase in Unimproved Value	73.5	55.3
	% „ „ Value of Improvements	25.8	73.2
	% „ „ Capital Value	51.0	61.2
600 - 899	No. farms	10	10
	% increase in Unimproved Value	78.1	71.0
	% „ „ Value of Improvements	42.2	46.7
	% „ „ Capital Value	62.5	61.3
900 +	No. farms	4	4
	% increase in Unimproved Value	83.0	69.2
	% „ „ Value of Improvements	46.0	69.0
	% „ „ Capital Value	66.6	67.6

NOTE: The number of farms in this table is considerably less than the number of Survey farms, mainly due to a surprising number of properties having been changed in area between the valuations.

The results of this examination are given in Table 8. Initial examination of the percentage change in the value of improvements would give the impression that there had been a much higher rate of investment and improvement of non-irrigated farms than irrigated farms over the five year period. But examination of the changes in the unimproved values shows that these have been disproportionate between the irrigated and non-irrigated groups. Thus, the most reliable figure is the change in capital values, and it is found that the increases tended to be greater on non-irrigated farms. This gives some confidence in asserting that there are no grounds for disputing the results of Section

VII on the basis of there being a higher level of indirect investment in the irrigated farms. Again, there is some indication that the opposite applies.

IX. CONCLUSION

During the past ten to fifteen years there has been a technological revolution in dry-land farming methods on the light land of the Canterbury Plains. It has resulted from basic improvement in the level of fertility by the use of lime and phosphate and subterranean clover, followed by the development of lucerne for fodder and grazing. This provided a basis for substantial increases in carrying capacity, based on appropriate stock policies. The use of D.D.T. for grass grub and porina control, and the development of fodder conservation policies, has sharply reduced the risk element in sheep farming under these semi-arid conditions.

As a result it has been evident in recent years that the margin between the productivity of irrigated and non-irrigated land has been narrowing. On the ten highest performing non-irrigated farms of the light land sample the average number of stock units ‡ carried on the area available for stock during the survey period was 3.1 per acre. The top four carried 3.7 stock units per available acre. The ten best irrigated farms carried an average of 4.5 stock units per available stock-acre, and of these the top four carried 5.2. These ten farms were all in the "heavy irrigators" class, except three, which were slightly less intensive irrigators. * But this difference in productivity was not sufficient to result in higher economic returns. The average Owner's Surplus on the ten irrigated farms was £1,636 and on the ten non-irrigated farms was £1,724.

The conclusion from this study of high performing farms, and from the whole survey, is that, under present technology, irrigation is not conferring sufficient gains in productivity to offset the additional investment involved and the higher costs associated with running an irrigated farm.

‡ See appendix 2 for conversion of livestock to stock units.

* Both the irrigated and non-irrigated farms in this analysis were less than 600 acres.

Changes in technology, such as the advent of automatic irrigation, or a swing in the pattern of irrigated farming towards more intensive cash cropping could possibly affect the situation. But there is no firm foundation for any such assertion; indeed there is no indication in the

survey results of any association between the intensity of cropping and the level of profitability on irrigated farms. Sharp increases in sheep product prices, compared with the average figures for the survey period, would also tend to favour the irrigated farms because of their higher output of sheep products. But again this would not be a firm basis on which to make decisions about water charges. No evidence has emerged from this survey which indicates that irrigation farmers are generally in any better position to meet additional higher costs than non-irrigators. Nor would it appear reasonable to assume any significant change in this situation in the immediate future.

APPENDIX 1

A_2 Plant and Machinery

This was determined by taking the opening book valuations for 1959, 1960 and 1961 and the closing valuations for 1962 for all the plant and machinery, except the motor car, and averaging these entries. Depreciation was standardized at 20 per cent. per annum for motorized plant and 10 per cent. for non-motorized. No special depreciation was allowed. Where machinery was sold during the three-year period and the sale price differed from the book value, the sale price was taken as the book value, and the preceding valuations were recalculated from this. Hence any gain or loss on sale shown in the Profit and Loss Account was eliminated.

APPENDIX 2

A_3 Livestock

The stock numbers were obtained at the field inspection. The values used were a standardized estimate of market values appropriate to the whole period. These values are listed below. Any wether lambs on hand at balance day were not valued, unless rearing of wether hoggets was practised. Stock bought in and fattened were ascribed a value proportionate to the length of time on the farm.

Breeding ewes —	
(i) Romney mixed age	50/-
(ii) Romney 4 and 5 year	35/-
(iii) Corriedale mixed age	45/-
(iv) Corriedale 4 and 5 year	30/-
Ewe hoggets —	
(i) Romney	50/-
(ii) Corriedale	45/-
Wethers	40/-
Wether hoggets — A fraction of 40/- depending on the time on the property.	
Rams — all breeds	100/-
Stud sheep —	
(i) Ewes	80/-
(ii) Ewe hoggets	60/-
(iii) Ram hoggets	100/-
(iv) Rams	160/-
Beef breed cows	£25
Rising 2-year heifers	£20
Rising 1-year heifers	£15
Bullocks	£30
Rising 2-year steers	£20
Rising 1-year steers	£15
Bulls	£50
Dairy Cows	£25
Dairy heifers	£25
Dairy yearlings	£15
Sows	£12
Weaner pigs	£5

Stock Units —

Romney ewes	1
Corriedale ewes	0.9
Hoggets	0.67
Trading stock	Part thereof — according to period on farm
Breeding cattle	6
Cattle (rising 2-year)	4
Cattle (rising 1-year)	3

APPENDIX 3

Analysis of variance

From Table 5, "F" ratios were calculated for the three size groupings of farms, yielding the following results:

Group	No. of Cells	Calculated "F" Ratio	
1.	2	8.32	Significant at 5%
II.	4	1.02	Not Statistically Significant
III.	4	1.25	Not Statistically Significant

For farms above 700 acres there were not sufficient numbers in any size group to warrant statistical analysis.

APPENDIX 4

Alternative groupings of farms on basis of level of total farm capital

An alternative to the grouping of farms on the basis of their size in acres, is grouping according to the level of total farm capital. In some respects this is more logical than the acreage classification, because the level of total farm capital gives a more precise specification of the size of the farm business. The following data are for a grouping on this basis.

Code:
1. No. of farms.
2. Average Total Farm Capital (£).
3. Average Area in Acres.
4. Average Acre/Ft. of water per Acre of Farm.
5. Average Owner's Surplus (£).

	Total Farm Capital	Code	a. Non-Irrigators	b. Light Irrigators	c. Medium Irrigators	d. Heavy Irrigators
I.	< 25,000	1.	12	4	4	5
		2.	22,120	22,763	23,850	20,161
		3.	446	377	334	281
		4.	—	0.25	0.65	1.22
		5.	940	526	1,421	—118
II.	25,000	1.	8	4	9	6
	29,999	2.	27,926	27,949	26,799	27,260
		3.	559	449	364	375
		4.	—	0.25	0.65	0.96
		5.	1,931	1,530	887	1,061
III.	30,000	1.	12	8	7	5
	39,999	2.	35,322	33,419	34,042	31,746
		3.	746	546	424	432
		4.	—	0.25	0.60	0.95
		5.	1,757	1,320	902	900
IV.	> 40,000	1.	11	4	7	2
		2.	51,158	51,915	50,748	51,675
		3.	1,052	974	815	691
		4.	—	0.13	0.51	0.92
		5.	1,635	2,186	742	2,582

TABLE OF "F" RATIOS FOR THE ABOVE GROUPS

Group	"F" for Group	
I.	5.66	Significant at 1%
II.	4.27	Significant at 5%
III.	1.74	Not Statistically Significant.
IV.	1.40	Not Statistically Significant.

APPENDIX 5

Irrigation and the level of economic activity

It has not been the purpose of this report to present a case for or against irrigation on the Canterbury Plains. The purpose has been merely to present the facts as found in the survey, relating to the comparative profitability of irrigation and dry farming on the plains, as a basis for consideration of equitable water charges. But it would give an incomplete picture of the impact of irrigation on the area and the community in general if attention were not drawn to some aggregate aspects.

Under intensive irrigation the whole level of economic activity in a region is increased. This is in respect of the number of farms, and farm families, and farm workers, supported by an area of land, the total level of capital invested, the total value and physical volume of production, and the total volume of business associated with farming. The latter includes transport, fertiliser production, freezing works, wool and grain handling, agricultural contracting, general merchandising, and other commercial and professional services.

In the accompanying table an attempt has been made to give a fair indication of these differences. The procedure adopted was to select all those farms in the survey which came into the category of heavy irrigators, that is, those whose average annual use of water was at least equal to 0.79 acre feet of water per acre of the farm over the survey period. There were 17 farms, with a total area of 6770 acres. Their results are given in column A of the table. Then from the sample of non-irrigated farms, individual farms were randomly selected until their total area was approximately equal to that of the heavily irrigated farms. The results for these 9 farms are given in column B. Column C contains corresponding figures for a group of 7 high performing non-irrigated farms. This column was added because it was thought that in selecting only heavy irrigators for the comparison, a bias may have been introduced. It is likely that a group of heavy irrigators would contain a high proportion of energetic and perhaps progressively minded farmers. Certainly it contains a high proportion of smaller farms, where the objective would be high physical output.

COMPARISON OF INPUT - OUTPUT DATA BETWEEN INTENSIVELY IRRIGATED AND NON-IRRIGATED FARMS (1)

		Non-Irrigated	
	Irrigated (2)	Random	High Performance
No. of farms	17	9	7
Total area (acres)	6,770	6,754	6,812
Value of Improvements	£156,005	£78,812	£88,432
Unimproved Value	£195,970	£157,900	£170,015
Capital Value	£351,973	£236,712	£258,447
Total Farm Capital	£499,284	£317,527	£339,762
Labour Units (3)	28.8	20.6	15.2
Area Cash Crop (acres)	247	658	731
Area Small Seeds (acres)	14	70	95
No. of Breeding Ewes	20,851	12,748	12,998
No. other Sheep	6,798	2,241	2,510
No. Cattle	434	151	210
Total Livestock Units (4)	26,651	14,734	15,480
Gross Output	£104,549	£70,897	£77,122
Total Non Factor Inputs (5)	£38,644	£25,074	£24,500

NOTES:
1. Figures are for the annual average of the 3 survey years.
2. Those farms which applied more than 0.79 acre-feet of water per acre of the farm.
3. Adult male equivalents.
4. See appendix 2 for conversion rates.
5. All inputs other than land, labour and capital, i.e. Items C_2 (Vehicle and Machinery Expenses), C_3 (Contract and Cartage), C_4 (Repairs and Maintenance), C_5 (Farm Purchases).

The figures in the table are annual averages of the survey years. They give a reasonably good indication of the different levels of economic activity between the groups. The total value of production was 50 per cent. greater on the irrigated area than on the randomly selected dry area, and 35 per cent. greater than on the high performing dry farms. This is also a reasonable indication of the differences in the volume of production.

Similarly, the total value of non-factor inputs was 50 per cent. greater on the irrigated farms, and the level of employment of labour and capital was higher. These ratios give a reasonable measure of the difference in the total level of economic activity which would be generated by the irrigation scheme were all the farms within the scheme irrigating at a reasonably high level. To the extent that a large proportion of farms irrigate less intensely the overall difference is less.

Whether the criteria of closer settlement, higher volume of production, and higher levels of economic activity generally ought to be applied to any argument for or against an irrigation scheme is a matter beyond the immediate scope and objectives of this report. Furthermore such criteria clearly can not be considered in isolation from the whole question of social investment in land improvement.

The crucial question is whether the differences in net output indicated by this table represent an adequate return for the social and private investment which has taken place.